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Influence of sub-grid scale parameterizations on atmospheric variability over a heterogeneous agricultural area

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Virtually all remote sensing based Soil-Vegetation-Atmosphere Transfer (SVAT) Schemes assume homogeneous, or decoupled atmospheric variables over their modeling domain. This assumption can lead to erroneous flux estimation since landscapes are inherently heterogeneous with variability in land surface state variables inducing spatial variability in the near surface air properties, which in turn affect the fluxes.

A Large Eddy Simulation (LES) model is coupled to a remote sensing based SVAT that accounts for soil and vegetation (dual source) contributions to mass and energy exchanges in order to study the feedback effects between spatially variable land cover and spatial variability in fluxes, through the induction of spatial variability in the lower atmosphere. Previous studies demonstrated that an increase in the correlation between surface and lower boundary layer states with increasing surface state contrast modulated relative increases in the spatial variance in the sensible heat flux. A multi-scale analysis of the land – atmosphere feedback, using a simple wavelet decomposition technique, showed the most significant correlation at scales from 500 to 1000 m. These feedback effects act to limit the spatial variability in the flux, implying that ignoring atmospheric feedback from land surface turbulent exchange rates will cause the largest errors at the extremes.

To improve the modelling of spatially distributed fluxes a better understanding of how the surface heterogeneities are transported into the lower atmospheric boundary layer is needed. Near the surface the momentum and scalar (temperature and moisture) transport is dominated by the smallest size eddies. Therefore, typically the performance of Large Eddy Simulation models near the surface depends largely on the performance of the so-called Sub-Grid-Scale (SGS) parameterizations of momentum and scalar fluxes. The effect of recently developed scale-invariant and scale-dependent dynamic SGS models for viscosity and diffusivity is discussed using airborne and ground-based observations from a campaign (REFLEX-2012) over a heterogeneous agricultural area in the southern part of Spain.